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# OPERATING COSTS OF AIRCRAFT AND FLIGHT SIMULATORS

Jesse Orlansky
Mark I. Knapp
Joseph String

March 1984

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This paper presents data and analyses of the operating costs of flight simulators and aircraft used in military training. The results should be useful in cost-effectiveness analyses of ongoing flight training programs. The effectiveness of flight simulators for training, however, is not addressed in this paper; hence, the findings of this study alone do not provide the basis for judgments or decisions that require both cost and effectiveness data.

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1. The average variable operating costs of 39 simulators in use in the FY 1980-1981 time period fall within a narrow range ($116 to $170 per operating-hour), despite the diversity of simulator types and associated aircraft missions (e.g., bomber, fighter, cargo), and aircraft sizes or types (i.e., fixed-wing or rotary-wing).

2. The simulator-to-aircraft operating cost ratios were about the same in the FY 1975-1976 and FY 1980-1981 time periods (27 and 39 combinations, respectively); the median value was 8 percent.

3. No relationship was found between the type of simulators, as categorized by the Services (e.g., Part Task Trainer, Cockpit Procedures Trainer, Weapon Systems Trainer) and its operating costs.

4. Data pertaining to a heterogeneous group of 15 Air Force simulator/fixed-wing aircraft that were operational in both the FY 1976-1977 and FY 1980-1981 time periods indicate that:

a. Both aircraft and simulator operating costs approximately doubled, so that average and median simulator-to-aircraft variable operating cost ratios were similar in both time periods.
b. The entire increase in average aircraft operating costs is consistent with the rate of economic inflation, while only about 40 percent of the increase in average simulator operating costs can be attributed to inflation. Data limitations precluded explanation of the remainder of the growth in simulator operating costs.
c. Simulator utilization by the Air Force was about 30 percent lower in FY 1980-1981 than in FY 1976-1977.

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1801 N. Beauregard Street
Alexandria, Virginia 22311

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## FOREWORD

This study was performed for the Office of the Deputy Under Secretary of Defense Research and Engineering (Research and Advanced Technology) under the technical cognizance of the Military Assistant for Training and Personnel Technology. The technical officer is Captain Paul R. Chatelier, USN. This paper is one of a series concerned with the effectiveness and cost of military training.

The cost data reported in this paper were collected by Joseph String when he was a member of the Institute for Defense Analyses. Joseph String is now employed by Rockwell International.

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## SUMMARY

This paper presents data and analyses of the operating costs of flight simulators and aircraft used in military training. The results should be useful in cost-effectiveness analyses of ongoing flight training programs and of the operating and support phases of new flight training programs. The effectiveness of flight simulators for training, however, is not addressed in this paper; hence, the findings of this study alone, as summarized below, do not provide the basis for judgments or decisions that require the results of both cost and effectiveness analyses.

1. The average variable operating costs of 39 simulators in operation in the FY 1980-1981 time period fall within a narrow range ($116 to $170 per operating-hour), despite the diversity of simulator types and associated aircraft missions (e.g., bomber, fighter, cargo), sizes, or types (i.e., fixed-wing or rotary-wing). (See Section C.3.c.)

2. The simulator-to-aircraft operating cost ratios in the FY 1975-1976 and FY 1980-1981 time periods (27 and 39 combinations, respectively) are essentially the same. (See Section D.1.)

3. No relationship was found between the type of simulators, as categorized by the Services (e.g., Part Task Trainer, Cockpit Procedures Trainer, Weapon Systems Trainer) and its operating costs. (See Section C.3.c.)

4. Data pertaining to a heterogeneous group of 15 Air Force simulator/fixed-wing aircraft that were operational in both the FY 1976-1977 and FY 1980-1981 time periods indicate that (see Section D.2):

a. Both aircraft and simulator operating costs approximately doubled, so that average and median simulator-to-aircraft variable operating cost ratios were similar in both time periods.

b. The entire increase in average aircraft operating costs is consistent with the rate of economic inflation, while only about 40 percent of the increase in average simulator operating costs can be attributed to inflation. Data limitations precluded explanation of the remainder of the growth in simulator operating costs.

c. Simulator utilization by the Air Force was about 30 percent lower in FY 1980-1981 than in FY 1976-1977.

## ABBREVIATIONS

| | |
|---|---|
| ATC | Air Training Command |
| CPT | Cockpit Procedures Trainer |
| FS | Flight Simulator |
| GFE | Government-Furnished Equipment |
| HQ | Headquarters |
| MAC | Military Airlift Command |
| M/D/S | Mission/Design/Series |
| NCLT | Night Carrier Landing Trainer |
| O&M | Operations and Maintenance |
| OFT | Operational Flight Trainer |
| P&A | Pay and Allowances |
| POL | Petroleum, Oil, and Lubricants |
| PTT | Part Task Trainer |
| SAC | Strategic Air Command |
| TAC | Tactical Air Command |
| VAMOSC | Visibility and Management of Operating and Support Costs |
| WST | Weapon Systems Trainer |

# OPERATING COSTS OF MILITARY AIRCRAFT AND FLIGHT SIMULATORS

## A. PURPOSE

The purpose of this paper is to provide and analyze recent data on the costs of operating military aircraft and flight simulators. This information is needed to evaluate the cost-effectiveness of current flight training programs, and should be useful in estimating the cost-effectiveness of future flight training programs.

This paper, however, does not consider the effectiveness of flight simulators for military training; therefore, the findings of this study, alone, do not provide a sufficient basis for any judgment or decision that requires the results of a cost-effectiveness analysis. A relevant example is the establishment of the optimum combination of aircraft flying time and simulator time in flight training.

## B. BACKGROUND

Flight simulators are used widely for purposes of training and evaluation, both in civil and military flying. Limited at one time largely to undergraduate flight training, their use extends now to advanced training for high performance operational aircraft, combat engagement, use of weapon systems, and aerial refueling. The well-known reasons for their use include lower operating costs; safety; independence of weather, air traffic, and geography; and their excellent amenability to performance measurement.

It is obvious that flight simulators cost less to operate than do aircraft. Nevertheless, it is still important to know the magnitude of that difference, that is, the precise ratio

of simulator-to-aircraft operating costs. For extant flight training programs the optimum combinations of simulators and aircraft can be determined by comparing their operating cost ratios to their relative effectiveness (i.e., the transfer effectiveness ratio).

According to data presented in an earlier study, the use of flight simulators can reduce the amount of flight time needed to establish a specified level of proficiency on a wide variety of flying tasks (Orlansky and String, 1977). The amount of flight time saved was estimated as about half the amount of time spent on that task in a flight simulator. Although the same study found that the median cost ratio of 33 simulator/aircraft combinations was 12 percent in FY 1975-1976, that value represents a mix of military and commercial airline equipment. The data for the military equipment, only, indicate a simulator-to-aircraft operating cost ratio of eight percent.

This paper (a) presents data and analysis for the FY 1980-1981 time period that are comparable to that of the FY 1975-1976 era reported in the earlier study, (b) discusses differences and similarities in operating costs between the two time periods and, (c) compares and evaluates operating costs of 15 Air Force simulator/fixed-wing aircraft combinations that were in inventory in both the FY 1976-1977 and FY 1980-1981 periods.

## C. OPERATING COSTS IN FY 1980-1981

### 1. Aircraft and Simulators in the Data Base

The data base developed for this paper comprises 39 military aircraft/simulator combinations for which cost data were available for the FY 1980-1981 time period.[1]

[1]Cost data for the FY 1980-1981, FY 1975-1976, and FY 1976-1977 eras are compared in Section D below. The development of the data base for the FY 1975-1976 period is discussed in Orlansky and String, 1977.

The 34 aircraft in the sample cover the full spectrum of military missions; fighter, attack, cargo, bomber, reconnaissance, utility, patrol, and electronic warfare. Eight rotary-wing and 26 fixed-wing aircraft are included.

It is recognized that the characteristics of simulators vary widely, primarily as a result of the type of training for which a simulator is designed, the characteristics of the aircraft it is intended to simulate, and the technology available at the time of its development. It follows that a number of simulators designed to perform the same type of training task may exhibit disparate degrees of complexity and markedly different investment and operating costs. For the purpose of this paper, however, we used the categories assigned by the Services, as follows:

| | |
|---|---|
| Cockpit procedures trainer | CPT |
| Part task trainer | PTT |
| Operational flight trainer | OFT |
| Flight simulator | FS |
| Night carrier landing trainer | NCLT |
| Weapon systems trainer | WST |

## 2. Cost Methodology

Variable operating costs are costs that vary as a function of the amount of usage of equipment, i.e., they exclude operating costs that are independent of rate of usage. The complete list of cost elements, shown in Table 1, was used to compile the variable operating costs of aircraft and simulators treated in this study.[1]

---

[1]The high costs associated with peacetime attrition of aircraft and aircrews that could be avoided by substituting simulator time for flying time can be considered a valid element for comparison. They were omitted in this paper, however, so as not to bias results heavily in favor of simulator utilization.

Table 1. COST ELEMENTS USED TO COMPUTE VARIABLE OPERATING COST PER HOUR OF AIRCRAFT AND SIMULATORS (FY 1980-1981)

| Costs | Aircraft (in Operational Unit) | Simulator |
|---|---|---|
| Inventory | a | x |
| Annual Utilization: Total Hours | a | x |
| Average Hours per Unit | x | x |
| Instructor Pay and Allowances | - | x |
| Other Military Pay and Allowances | - | x |
| Civilian Pay and Allowances | - | x |
| Maintenance Materials and Supplies | x | x |
| Replenishment Spares | x | - |
| POL | x | - |
| Utilities | - | x |
| Contract Maintenance and Supplies | - | x |
| Depot Maintenance | x | - |
| Training Munitions | x | - |

[a]Included for Navy only, to compute aircraft average flying hours. Average flying hours available for Air Force and Army.

-Not utilized in computations.

xApplicable to computation of operating cost per hour.

Certain of the elements listed were not included in computations of variable cost per hour for aircraft in operational units for the following reasons:

Instructor pay and allowances — Personnel are not assigned for the sole purpose of instruction.

| | |
|---|---|
| Other military pay and allowances and<br>Civilian pay and allowances | Operational units are sized for combat and contingency potential. The numbers of personnel assigned do not vary with peacetime activity rates. This applies also to base maintenance labor, which is, therefore, omitted. |
| Utilities | Do not vary with flight activity. |
| Contract maintenance and supplies | Aircraft maintenance in operational units usually is done organically. |

Similarly, several cost elements were excluded from calculations of simulator cost per operating-hour:

| | |
|---|---|
| Petroleum, oil, and lubricants (POL) | Not utilized in training device operations. |
| Replenishment spares | Usually not explicitly identified in available data; may be included under Contract Maintenance and Supplies. |
| Depot maintenance | Usually included in the reported depot maintenance cost of the associated aircraft, so is not identifiable. |
| Training munitions | None are expended in flight simulator operations. |

The cost elements that were used to compute variable operating cost per aircraft flying-hour and per simulator operating-hour[1] are defined and reported in this paper, as follows:

[1]Aircraft cost per flying-hour, aircraft cost per operating-hour, and simulator cost per operating-hour are considered comparable in this paper. While aircraft operating-hours exceed actual flying hours by some small increment (e.g., for maintenance ground testing), routine reports generated by the Services rarely discriminate between the two. Similarly, it is probable that actual simulator operating-hours exceed the values reported as training utilization by some amount.

Maintenance Materials and Supplies: Relatively low-unit-cost materials and supplies stocked at base level.

Replenishment Spares: Relatively high-unit-cost replacement parts and subsystems. Excludes War Readiness Material.

Petroleum, Oil, and Lubricants (POL): Fuel consumed per flying-hour. Excludes consumption of oil and lubricants, the costs of which are trivial in this context.

Depot Maintenance: Includes organic civilian labor, materials and overhead, contractor maintenance and Government-Furnished Equipment (GFE) to contractor. Includes only those costs that vary with flying-hour activity level (i.e., excludes fixed depot costs).

Training Munitions: Cost of annual authorization per aircrew, reduced to cost per flying-hour.

Instructor Pay and Allowances (P&A): Taken as $30 for Air Force SAC and MAC simulators, and $28 for Air Force TAC, Army, and Navy simulators; more than one instructor is required for some devices. These values were determined by dividing the average annual P&A of an O-3 (Army/Marine/Air Force captain and Navy lieutenant) by 1,000 direct instructional (i.e., direct student contact) hours per year. Although military personnel of various grades act as instructors, we chose to use a common grade (O-3) for comparability among all Services.

It was not always possible to identify all of the cost elements in Table 1 for all aircraft-simulator combinations because some of the data available to us were either incomplete or provided aggregate totals. Furthermore, peculiarities of the various sources of data required different methods of data reduction to approximate comparability of operating costs per hour. These are discussed in the next section, where aircraft and simulator operating costs for FY 1980-1981 are presented.

## 3. Aircraft and Simulator Operating Costs

Table 2 presents the variable operating costs per hour of 39 military aircraft/simulator pairs for which cost data were available for the FY 1980-1981 time period. Derivation of the entries, by Service, are discussed in the following paragraphs.

### a. Aircraft

#### (1) Air Force Aircraft

Excepting Training Munitions, the operating costs of Strategic Air Command (SAC) aircraft[1] in Table 2 were taken from Table 2-2 of [1].[2] Training Munitions costs were computed from values in Tables 2-5 and 4-4 in [1]. The costs of of SAC aircraft are expressed in FY 1981 dollars.

With the exception of Training Munitions, the costs of most of the Tactical Air Command (TAC) aircraft[3] in Table 2 were determined from Table 13 of [2]. Those costs are given as FY 1981 dollars, but were deflated to FY 1980 dollars for Table 2. Training Munitions costs were computed with reference to Tables 7 and 32 of [2].

Costs of Military Airlift Command (MAC) aircraft[4] were extracted from Table 2-2 of [1], and are expressed in FY 1981 dollars in Table 2. Training Munitions, included in the costs of the CH-3 and H-53, were computed from values in Tables 2-5 and 4-4 in [1].

#### (2) Navy Aircraft

The variable flying-hour costs of all Navy aircraft were derived from VAMOSC-Air TSS reports [3] for FY 1979.

---

[1] B-52D/G/H, KC-135A, and FB-111.

[2] Numbers in brackets ([ ]) are keyed to the list of References for Cost Data at the end of this paper.

[3] E-3A, F-4D/E, F-15, F-111A/D, and RF-4C.

[4] C-130E, C-141A, WC-135B, CH-3, H-53, and C-5A.

Table 2. VARIABLE OPERATING COSTS PER HOUR OF AIRCRAFT AND SIMULATORS

(FY 1980 and 1981)

| Class (Type) of Simulator and Service | Aircraft | Simulator | Cost per Flying Hour in Operational Units (Excluding Attrition) | Simulator Cost Per Hour | Simulator-to-Aircraft Cost Ratio |
|---|---|---|---|---|---|
| CPT/PTT | | | | | |
| Army | UH-1H | 2C35 | 211 | 37 | 0.17 |
| Navy | E-2C | 2C20A | 1073 | 320 | 0.30 |
| | F-4J | 2C17 | 2250 | 133 | 0.06 |
| | P-3A/B | 2C45 | 1318 | 139 | 0.10 |
| | SH-3H | 2C44 | 716 | 266 | 0.37 |
| Air Force | B-52D | MB41 | 6420 | 185 | 0.03 |
| | B-52G | T1 | 6367 | 133 | 0.02 |
| | B-52H | T25 | 5671 | 151 | 0.03 |
| | KC-135A | MB26 | 3242 | 117 | 0.04 |
| | T-38 | T26A | 1098 | 87 | 0.08 |
| | C-130E | T19 | 1419 | 89 | 0.06 |
| OFT/FS/NCLT | | | | | |
| Army | UH-1H | 2B24 | 211 | 58 | 0.27 |
| | CH-47 | 2B31 | 1013 | 231 | 0.23 |
| | AH-1 | 2B33 | 545 | 322 | 0.59 |
| Navy | A-7E | 2F103 | 1229 | 119 | 0.10 |
| | F-14A | 2F95 | 2885 | 87 | 0.03 |
| Air Force | FB-111 | T36 | 4470 | 214 | 0.05 |
| | A-7D | T33 | 1917 | 129 | 0.07 |
| | E-3A | -- | 5489 | 122 | 0.02 |
| | F-4D | T3 | 2660 | 234 | 0.09 |
| | F-4E | T9 | 2710 | 185 | 0.07 |
| | F-15 | T49 | 3518 | 111 | 0.03 |
| | F-111A | T31 | 4080 | 150 | 0.04 |
| | F-111D | T35 | 4150 | 177 | 0.04 |
| | RF-4C | T2 | 2104 | 195 | 0.09 |
| | C-141A | T24 | 2872 | 120 | 0.04 |
| | WC-135B | T23 | 2841 | 211 | 0.07 |
| | CH-3 | T42 | 628 | 116 | 0.18 |
| | H-53 | T43 | 1159 | 122 | 0.10 |
| WST | | | | | |
| Navy | A-6E | 2F114 | 1876 | 159 | 0.08 |
| | A-7E | 2F84B | 1229 | 93 | 0.08 |
| | A-7E | 2F111 | 1229 | 71 | 0.06 |
| | F-4J | 2F88 | 2250 | 97 | 0.04 |
| | P-3A/B | 2F69D | 1318 | 160 | 0.12 |
| | P-3C | 2F87 (F/T) | 1286 | 119 | 0.09 |
| | S-3A | 2F92A | 1452 | 254 | 0.17 |
| | SH-2F | 2F106 | 722 | 112 | 0.16 |
| | SH-3D | 2F64B | 1039 | 120 | 0.12 |
| Air Force | C-5A | T37 | 6123 | 124 | 0.02 |

They are expressed in FY 1980 dollars in Table 2. Line items were selected from [3] to compute values for the five elements of total variable operating cost per hour in operational units shown in Table 2, as follows:

| Cost Element | Computation from VAMOSC Report Line Items |
|---|---|
| Maintenance Materials and Supplies | (Organizational + Intermediate Maintenance Supplies) ÷ Flying Hours, Regular |
| Replenishment Spares | Recurring Investment, Replacement Repairables ÷ Total Flying Hours |
| POL | Organizational POL Costs ÷ Flying Hours, Regular |
| Depot Maintenance | (Subtotal Depot Support - Subtotal Aircraft Rework) ÷ Total Flying Hours |
| Training Munitions | Organizational Training Expendable Stores ÷ Flying Hours, Regular |

(3) Army Aircraft

Depot Maintenance costs came from [4] and/or [5]; Training Munitions cost (included in AH-1 cost, only) was obtained from [6].

b. Simulators

(1) Air Force Simulators

Pertinent data on flight simulators were acquired from the Air Force operational commands. Of the 290 devices in the Air Force inventory [7], the sample analyzed accounts for 91 of 116 devices held by SAC, TAC, and MAC.

Cost data and hours utilized for simulators associated with TAC aircraft were obtained from Headquarters, TAC [8]. The data covered 28 of the 43 simulators listed in the TAC worldwide inventory [7]. Enlisted and civilian personnel costs, utility costs, and "Other Operations and Maintenance (O&M)" costs

were furnished, and instructor costs were computed from the instructional crew sizes given by TAC. Costs were then reduced to a per-operating-hour value and expressed in Table 2 in FY 1980 dollars.

Data acquired for 39 of 45 active SAC simulators were limited to location, utilization rates, and enlisted personnel authorizations [9]. "Irstructor P&A" was computed assuming one instructor per simulator. "Other Military Pay and Allowances" was then computed for an average personnel grade of E-5. The sum of the applicable elements other than labor (in Table 1) were computed via ratios of non-labor to labor costs (based on TAC data) for each of the remaining simulators in the sample. SAC simulator costs per operating-hour are expressed in Table 2 in FY 1981 dollars.

Complete cost and operating-hour data were furnished by Hq, MAC [10, 11] for all currently active simulators in the MAC inventory. The element "Contract Maintenance and Supplies" (in Table 1) reportedly does not apply, and MAC explicitly stated that the costs of "Depot Maintenance" and "Replenishment Spares" were not provided because they were inextricably embedded in total M/D/S aircraft system costs. We used our standard method to compute Instructor P&A cost rather than the information provided by MAC. MAC simulator costs in Table 2 are expressed in FY 1981 dollars.

(2) Navy Simulators

Each Navy simulator cost shown in Table 2 is the sum of (a) cost data provided in [12] reduced to a per-operating-hour value and (b) Instructor P&A cost (constant $28 per hour), assuming one instructor-hour per simulator operating-hour. Costs are expressed in FY 1980 dollars. There are some inconsistencies and voids in these source data:

(a) In comparison with the Navy's inventory of 160 flight simulators [13], the sample of 23 for which cost and operating-hour information was provided in [12] is very small.

(b) Costs are probably understated because data on software support and replenishment spares were not made available.

(3) Army Simulators

Army flight training device data were furnished for units at Ft. Rucker [14]. "Other Military Pay and Allowances" and "Maintenance Materials and Supplies" are not explicitly addressed since Ft. Rucker relies heavily on contractors for simulator maintenance labor and replacement parts. As a result, "Contract Maintenance and Supplies" costs are considerably higher for Army devices than for comparable Navy and Air Force simulators.

Each Army flight simulator cost given in Table 2 is the sum of (a) costs furnished by Ft. Rucker and (b) Instructor P&A cost (constant $28/hr.), assuming one instructor-hour per simulator operating-hour.[1] Costs are expressed in FY 1980 dollars.

c. Results and Analysis (FY 1980-1981)

The variable operating costs per hour for aircraft in operational units and simulators, listed in Table 2, are shown graphically in Figure 1.

[1]Instructor P&A is not an element of the 2C35 CPT simulator. Its operation does not require instructor participation.

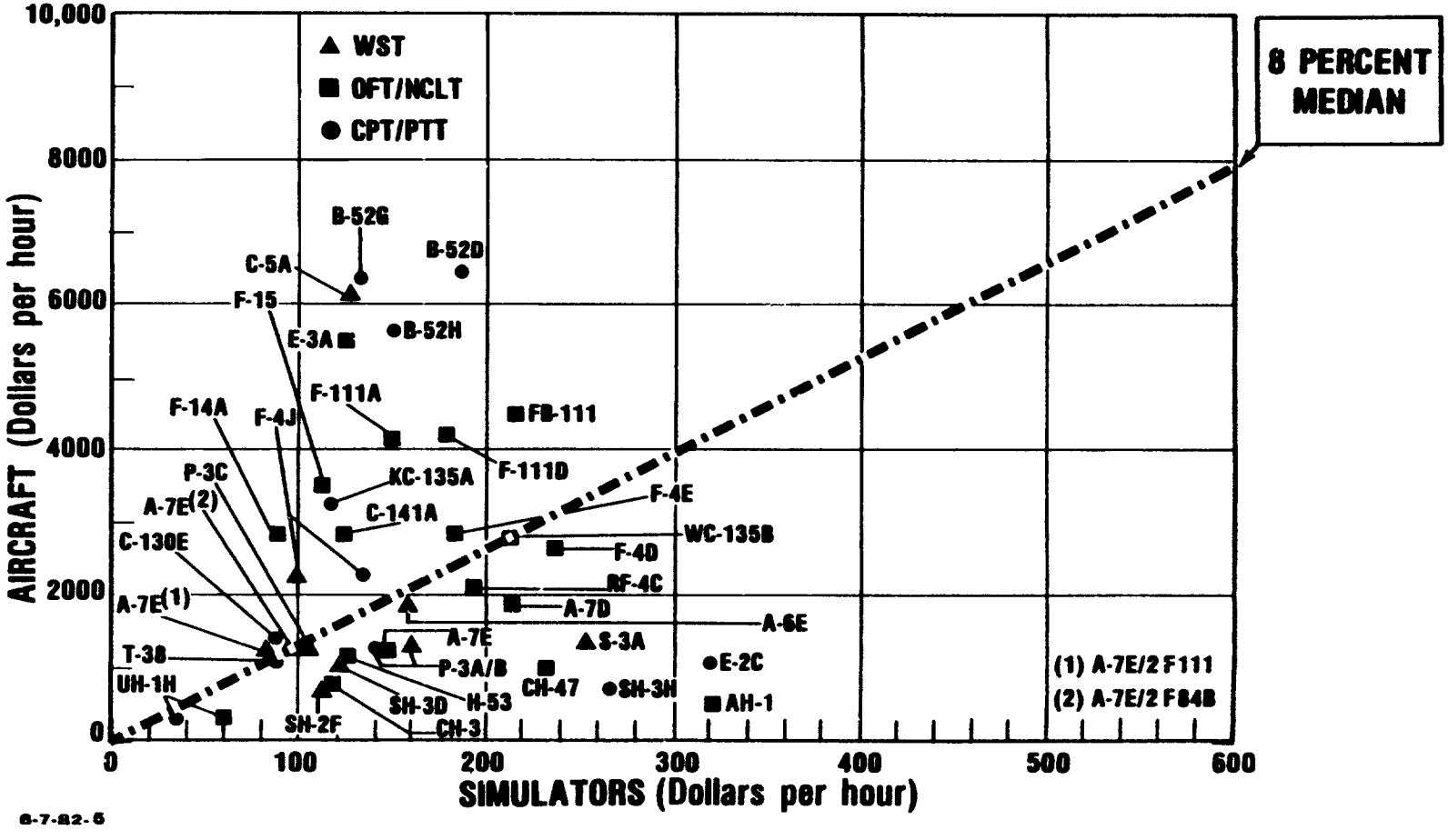


FIGURE 1. Variable Operating Costs per Hour for 39 Flight Simulators and Aircraft, FY 1980 and FY 1981

Three observations are apparent from Figure 1:

(1) The median ratio of the 39 military simulator-to-aircraft operating costs is eight percent in FY 1980-1981, the same as that found earlier for the FY 1975-1976 period.

(2) The scatter of operating cost data shows no pattern relevant to the way in which simulators are categorized by the Services (e.g., CPT, OFT, WST).

(3) The data points that represent rotary-wing aircraft/simulator operating costs fall within a relatively narrow band at the bottom of the figure.

These observations prompted a closer look at simulator operating costs. Table 3 presents the average and median simulator operating costs per hour (from Table 2), arrayed by simulator group and aircraft type. It reveals a relatively narrow range of average and median operating costs, despite the diversity of aircraft missions, sizes, and types (i.e., fighter, attack, cargo, bomber; fixed-wing and rotary-wing) and simulator categories (e.g., CPT/PTT, WST) in the data base. The stratification of points that represent rotary-wing aircraft/simulator pairs is traceable to relatively low costs per flying-hour over a narrow range,[1] while operating costs of the associated simulators range almost as widely as those of the fixed-wing aircraft ($37-$322 versus $71-$320 per hour, respectively). These data result in relatively high simulator:aircraft operating cost ratios for rotary-wing aircraft (averages are 0.24 for rotary-wing versus 0.07 for fixed-wing). Table 3 (and Figure 1) also suggests that it may not be feasible to develop a mathematical relationship to estimate simulator operating costs based only on simulator category and aircraft mission, size, or type.

[1]With reference to Table 2, the average rotary-wing aircraft cost per flying-hour is $754; the range is $211 to $1,158. The average fixed-wing cost per flying-hour is $3,096; the range is $1,073 to $6,420.

Table 3. VARIABLE OPERATING COSTS OF MILITARY AIRCRAFT SIMULATORS

(FY 1980 and FY 1981)

| Type of Simulator | Average FY 1980 - FY 1981 Dollars per Hour | | |
|---|---|---|---|
| | For Fixed-Wing Aircraft | For Rotary-Wing Aircraft | Total |
| CPT/PTT | | | |
| Cost | 150 | 152 | 151 |
| (No.) | (9) | (2) | (11) |
| OFT/FS/NCLT | | | |
| Cost | 158 | 170 | 161 |
| (No.) | (13) | (5) | (18) |
| WST | | | |
| Cost | 135 | 116 | 131 |
| (No.) | (8) | (2) | (10) |
| All Types | | | |
| Cost | 150 | 154 | 151 |
| (No.) | (30) | (9) | (39) |
| | Median FY 1980 - FY 1981 Dollars per Hour | | |
| All Types | | | |
| Cost | 133 | 120 | 124 |
| (No.) | (30) | (9) | (39) |

## D. COMPARISONS OF OPERATING COST DATA: FY 1980-1981 VERSUS FY 1975-1976 AND FY 1976-1977

### 1. FY 1980-1981 and FY 1975-1976

A direct comparison of military simulator-to-aircraft operating cost ratios for the FY 1975-1976 and FY 1980-1981 time periods is provided in Table 4. Data for the later era are contained in Table 2. Data for the FY 1975-1976 period represent the 27 military aircraft/simulator combinations

Table 4. COMPARISON OF MILITARY SIMULATOR-TO-AIRCRAFT VARIABLE OPERATING COST RATIOS

FY 1975-1976 and FY 1980-1981

| | FY 1975-1976[a] | | | FY 1980-1981[b] | | |
|---|---|---|---|---|---|---|
| No. of Simulator/ Aircraft Combinations in Sample | | | | | | |
| Fixed-Wing | 20 | | | 30 | | |
| Rotary-Wing | 7 | | | 9 | | |
| Total | 27 | | | 39 | | |
| | Measures of Central Tendency | | | | | |
| | Range | Average | Median | Range | Average | Median |
| Fixed-Wing | 0.02-0.40 | 0.10 | 0.08 | 0.02-0.30 | 0.07 | 0.06 |
| Rotary-Wing | 0.02-0.31 | 0.16 | 0.12 | 0.10-0.59 | 0.24 | 0.18 |
| Total | 0.02-0.40 | 0.12 | 0.08 | 0.02-0.59 | 0.11 | 0.08 |

[a] Orlansky and String, 1977

[b] Table 2, this paper.

from a mix of 33 military and commercial airline aircraft/simulator pairs that constitute the data base in a study referred to earlier (Orlansky and String, 1977).

Table 4 presents, for each period, the sample size and measures of central tendency (range, average, and median) for the total sample and for the fixed-wing and rotary-wing simulator/aircraft pairs in the sample. The simulator/aircraft combinations that make up the data bases for the two time periods differ somewhat, but each includes a mix of military fixed-wing and rotary-wing aircraft of different types (e.g., fighter, attack, cargo, bomber). It is felt, therefore, that the sample sizes are sufficiently large and diverse to yield results that are, at least, indicative of each era.

The fixed-wing average and median operating cost ratios are somewhat lower in the FY 1980-1981 period than in FY 1975-1976.[1] The data show that the average fixed-wing aircraft operating cost doubled over the five-year interval (consistent with inflation), while the average operating cost of the associated simulators increased by about one-third.[2] Average and median rotary-wing operating cost ratios, on the other hand, increased markedly (by 50 percent) from the earlier to the later time period. The rotary-wing data show that the increase in average simulator operating cost substantially exceeded that of the average cost per flying-hour. In total, the average and median simulator:aircraft operating cost ratios show almost no change from FY 1975-1976 to FY 1980-1981 because the sizable increases in rotary-wing ratios offset the modest decreases in the fixed-wing ratios.[3]

## 2. FY 1980-1981 and FY 1976-1977

Table 5 permits more precise comparisons of simulator and aircraft operating costs over time than Table 4. FY 1980-1981 data are compared with FY 1976-1977 data using equivalent subsets of the data bases in Table 4; specifically, 15 Air Force simulator/aircraft combinations. Cost-element content is

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[1]Training Munitions is an element of aircraft operating cost in the FY 1980-1981 figures (see Table 1), but is not included for the earlier period. This disparity, however, accounts for less than 0.01 of the differences in the ratios.

[2]The cost of fuel (POL), which is an element of aircraft operating cost, but not of simulator operating cost (see Table 1), almost tripled over this five-year period. Escalation of the remaining elements of operating cost for both aircraft and simulators averaged about 40 percent [Ref. 1, Table 5.1].

[3]The 12 percent median operating cost ratio found and reported in Orlansky and String, 1977, resulted from the inclusion of six commercial airliner/simulator combinations in that data base. All six exhibited relatively high (12 to 23 percent) operating cost ratios.

Table 5. COMPARISON OF SIMULATOR UTILIZATION, VARIABLE COSTS, AND COST RATIOS FOR 15 AIR FORCE FIXED-WING AIRCRAFT

(FY 1976-1977 and FY 1980-1981)

| Aircraft/Simulator (Model/Design/Series) | Variable Flying-Hour Cost[a] | | Simulator Utilization (Avg. Hrs./Unit/Yr.) | | Variable Simulator Hourly Cost | | Cost Ratio = Simulator Hour / Flying Hour | |
|---|---|---|---|---|---|---|---|---|
| | FY 76-77 | FY 80-81 | FY 76-77 | FY 80-81 | FY 76-77 | FY 80-81 | FY 76-77 | FY 80-81 |
| B-52D/MB41 | 2801 | 6420 | 2142 | 848 | 67 | 185 | .02 | .03 |
| B-52G/T1 | 2841 | 6367 | 2551 | 1090 | 55 | 133 | .02 | .02 |
| B-52H/T25 | 2630 | 5671 | 2797 | 1057 | 43 | 151 | .02 | .03 |
| FB-111/T36 | 1951 | 4770 | 3247 | 2272 | 153 | 214 | .08 | .05 |
| KC-135/MB26 | 1595 | 3242 | 2619 | 1592 | 55 | 117 | .03 | .04 |
| F-4D/T3 | 1255 | 2660 | 992 | 1699 | 86 | 234 | .07 | .09 |
| F-4E/T9 | 1220 | 2710 | 2393 | 1884 | 63 | 185 | .05 | .07 |
| RF-4C/T2 | 1092 | 2104 | 2594 | 1746 | 60 | 195 | .05 | .09 |
| F-111A/T31 | 2240 | 4080 | 1566 | 2335 | 129 | 150 | .06 | .04 |
| F-111D/T35 | 2240 | 4150 | 3621 | 2342 | 73 | 177 | .03 | .04 |
| A-7D/T33 | 1024 | 1917 | 4315 | 2426 | 61 | 129 | .06 | .07 |
| C-5A/T37 | 3610 | 6123 | 4965 | 3015 | 80 | 124 | .02 | .02 |
| C-141/T24 | 1272 | 2872 | 5140 | 3798 | 75 | 120 | .06 | .04 |
| C-130E/T19 | 638 | 1419 | 3892 | 2957 | 75 | 89 | .12 | .06 |
| T-38/T26 | 518 | 1258 | 2062 | 1590 | 8 | 87 | .02 | .07 |
| Range | 518-3610 | 1258-6420 | 992-5140 | 848-3798 | 8-153 | 87-234 | .02-.12 | .02-.09 |
| Average | 1795 | 3717 | 2993 | 2043 | 72 | 153 | .05 | .05 |
| Median | 1595 | 3242 | 2619 | 1884 | 67 | 150 | .05 | .04 |

[a]Except for T-38, operational squadron costs exclude attrition and military personnel. Flying-hour costs for FY 76-77 are in FY 1977 dollars; FY 80-81 are in FY 1981 dollars.

similar for both periods (see Table 1), except for the omission of Training Munitions in FY 1976-1977.[1] Table 5 shows that:

a. The average and median simulator:aircraft operating cost ratios remained essentially unchanged over the four-year interval.

b. The average and median flying-hour costs doubled from FY 1976-1977 to FY 1980-1981, an increase consistent with the rate of inflation. The average and median simulator operating cost per hour also doubled over the same period, although only about 40 percent of the increase can be attributed to inflation. (See footnote 2, page 16). Data limitations preclude explanation of the remainder of the simulator operating cost growth.

c. Average and median simulator utilization decreased by 32 and 28 percent, respectively, from FY 1976-1977 to FY 1980-1981. We did not explore the reasons for the reduced utilization of flight simulators.

## E. SUMMARY OF FINDINGS

1. The variable operating costs of 39 simulators in the FY 1980-1981 period fall within a relatively narrow range ($116 to $170 per operating-hour), despite the diversity of simulator types and associated aircraft missions, sizes, and types.

2. The average and median simulator-to-aircraft variable operating cost ratios for the FY 1975-1976 and FY 1980-1981 time periods (27 and 39 combinations, respectively) are essentially the same. Sizable increases in rotary-wing operating cost ratios were offset by modest decreases in the fixed-wing ratios.

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[1]As explained in a previous footnote, the omission of Training Munitions accounts for less than 0.01 of the aggregate differences in simulator: aircraft operating cost ratios.

3. No relationship was found between simulator types (e.g., PTT, CPT, WST) and simulator variable operating costs. The operating cost of a simulator may be dependent primarily upon the training requirements and characteristics of the aircraft that the simulator is designed to reproduce, the technology available at the time of its development, and the level of complexity required to fulfill its function.

4. Data pertaining to a group of 15 Air Force simulator/fixed-wing aircraft that were in the operational inventory in FY 1976-1977 and FY 1980-1981 indicate that:

a. Both aircraft and simulator operating costs approximately doubled, so that average and median simulator-to-aircraft operating cost ratios were similar in both time periods.

b. The entire increase in average aircraft operating costs is consistent with the rate of economic inflation, while only about 40 percent of the increase in average simulator operating costs can be attributed to inflation. Data limitations precluded explanation of the remainder of the simulator operating cost growth.

c. Simulator utilization by the Air Force was about 30 percent lower in FY 1980-1981 than in FY 1976-1977.

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